AMENDMENTS TO CLAIMS

1. (Currently Amended) A differential amplifier that receives first and second input signals and generates first and second output signals, the differential amplifier comprising:

a first single-end differential converter including a first grounded emitter amplifier that receives the first input signal and generates a first differential output signal, and a first grounded base amplifier that receives the first input signal and generates a second differential output signal, wherein the first ground emitter amplifier includes a first transistor and a first resistor connected between an emitter of the first transistor and a ground; and

a second single-end differential converter including a second grounded emitter amplifier that receives the second input signal and generates a third differential output signal, and a second grounded base amplifier that receives the second input signal and generates a fourth differential output signal, wherein the second grounded emitter amplifier includes a second transistor and a second resistor connected between an emitter of the second transistor and the ground;

wherein the first output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal.

2. (Original) The differential amplifier according to claim 1, wherein the first and second differential output signals have reverse phases, and the third and fourth differential output signals have reverse phases .

3. (Previously Presented) A differential amplifier that receives first and second input

signals and generates first and second output signals, the differential amplifier comprising:

a first differential converter including a first grounded emitter amplifier that receives the first input signal and generates a first differential output signal, and a first grounded base amplifier that receives the first input signal and generates a second differential output signal; and

a second differential converter including a second grounded emitter amplifier that receives the second input signal and generates a third differential output signal, and a second grounded base amplifier that receives the second input signal and generates a fourth differential output signal;

wherein the first output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal,

wherein the first grounded emitter amplifier includes:

a first transistor,

a first resistor connected between an emitter of the first transistor and a ground,

a first capacitor connected to a base of the first transistor, for receiving the first input signal, and

a second resistor connected between the base of the first transistor and a bias voltage;

the first grounded base amplifier includes:

a second transistor,

a second capacitor connected between a base of the second transistor and the ground,

a third resistor connected between the base of the second transistor and the bias voltage,

a third capacitor connected to an emitter of the second transistor, for receiving the first input signal, and

a fourth resistor connected between the emitter of the second transistor and the ground;

the second grounded emitter amplifier includes:

a third transistor,

a fifth resistor connected between an emitter of the third transistor and the ground,

a fourth capacitor connected to a base of the third transistor, for receiving the second input signal, and

a sixth resistor connected between the base of the third transistor and the bias voltage; and

the second grounded base amplifier includes:

a fourth transistor,

a fifth capacitor connected between a base of the fourth transistor and the ground,

a seventh resistor connected between the base of the fourth transistor and the bias voltage,

a sixth capacitor connected to an emitter of the fourth transistor, for receiving the second input signal, and

an eighth resistor connected between the emitter of the fourth transistor and the ground;

wherein a collector of the first transistor is connected to a collector of the fourth transistor, and a collector of the second transistor is connected to a collector of the third transistor.

4. (Previously Presented) A differential amplifier that receives first and second input signals and generates first and second output signals, the differential amplifier comprising:

a first differential converter including a first grounded emitter amplifier that receives the first input signal and generates a first differential output signal, and a first grounded base amplifier that receives the first input signal and generates a second differential output signal; and

a second differential converter including a second grounded emitter amplifier that receives the second input signal and generates a third differential output signal, and a second grounded base amplifier that receives the second input signal and generates a fourth differential output signal;

wherein the first output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal,

wherein the first grounded emitter amplifier includes:

a first transistor, a base of which receives the first input signal, and

a first resistor connected between an emitter of the first transistor and a ground;

the first grounded base amplifier includes:

a second transistor,

a first capacitor connected between a base of the second transistor and the ground,

a third transistor, a collector of which is connected to an emitter of the second transistor, and a base of which is connected to its own collector and receives the first input signal, and

a second resistor connected between an emitter of the third transistor and the ground;

the second grounded emitter amplifier includes:

a fourth transistor, a base of which receives the second input signal, and

a third resistor connected between an emitter of the fourth transistor and the ground; and

the second grounded base amplifier includes:

a fifth transistor, a base of which is connected to the ground via the first capacitor,

a sixth transistor, a collector of which is connected to an emitter of the fifth transistor, and a base of which is connected to its own collector and receives the second

input signal, and

a fourth resistor connected between an emitter of the sixth transistor and the ground;

wherein a collector of the first transistor is connected to a collector of the fifth transistor, and a collector of the second transistor is connected to a collector of the fourth transistor.

5. (Previously Presented) A differential amplifier that receives first and second input signals and generates first and second output signals, the differential amplifier comprising :

a first differential converter including a first grounded emitter amplifier that receives the first input signal and generates a first differential output signal, and a first grounded base amplifier that receives the first input signal and generates a second differential output signal; and

a second differential converter including a second grounded emitter amplifier that receives the second input signal and generates a third differential output signal, and a second grounded base amplifier that receives the second input signal and generates a fourth differential output signal;

wherein the first output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal,

wherein the first grounded emitter amplifier includes:

a first transistor, a base of which receives the first input signal,

a first resistor connected between an emitter of the first transistor and a ground, and

a second transistor, an emitter of which is connected to a collector of the first transistor;

the first grounded base amplifier includes:

a third transistor,

a first capacitor connected between a base of the third transistor and the ground,

a fourth transistor, a collector of which is connected to an emitter of the third transistor, and a base of which is connected to its own collector and receives the first input signal, and

a second resistor connected between the emitter of the third transistor and the ground;

the second grounded emitter amplifier includes:

a fifth transistor, a base of which receives the second input signal, and

a sixth transistor, an emitter of which is connected to a collector of the fifth transistor; and

the second grounded base amplifier includes:

a seventh transistor, a base of which is connected to the ground via the first capacitor,

an eighth transistor, a collector of which is connected to an emitter of the

seventh transistor, and a base of which is connected to its own collector and receives the second input signal, and

a fourth resistor connected between an emitter of the eighth transistor and the ground;

wherein a collector of the second transistor is connected to a collector of the seventh transistor, and a collector of the third transistor is connected to a collector of the sixth transistor.

6. (Original) A differential converter comprising:

an input-stage differential converter including a first grounded emitter amplifier that receives an original input signal and generates a first differential input signal, and a first grounded base amplifier that receives the original input signal and generates a second differential input signal; and

a differential amplifier connected to the input-stage differential converter, for receiving the first and second differential input signals and generating first and second output signals, wherein the differential amplifier includes:

a first output-stage differential converter including a second grounded emitter amplifier that receives the first differential input signal and generates a first differential output signal, and a second grounded base amplifier that receives the first differential input signal and generates a second differential output signal, and

a second output-stage differential converter including a third grounded emitter amplifier that receives the second differential input signal and generates a third differential

output signal, and a third grounded base amplifier that receives the second differential input signal and generates a fourth differential output signal, wherein the first output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal.

7. (Previously Presented) A mixer that mixes first and second input signals with first and second carrier signals to generate first and second mixer output signals, the mixer comprising:

a differential amplifier that receives the first and second input signals and generates first and second output signals, wherein the differential amplifier includes,

a first single-end differential converter including a first grounded emitter amplifier that receives the first input signal and generates a first differential output signal and a first grounded base amplifier that receives the first input signal and generates a second differential output signal, wherein the first grounded emitter amplifier includes a first transistor and a first resistor connected between an emitter of the first transistor and a ground; a second single-end differential converter including a second grounded emitter amplifier that receives the second input signal and generates a third differential output signal, and a second grounded base amplifier that receives the second input signal and generates a fourth differential output signal, wherein the second grounded emitter amplifier includes a second transistor and a second resistor connected between an emitter of the second transistor and the ground, wherein the first output signal is generated by coupling

the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal; and

a pair of differential circuits connected to the differential amplifier, for receiving the first and second output signals and the first and second carrier signals to generate the first and second mixer output signals.

8. (Original) A mixer that mixes an original input signal with first and second carrier signals to generate first and second mixer output signals, the mixer comprising:

an input-stage differential converter including a first grounded emitter amplifier that receives the original input signal and generates a first differential input signal, and a first grounded base amplifier that receives the original input signal and generates a second differential input signal;

a differential amplifier connected to the input-stage differential converter, for receiving the first and second differential input signals and generating first and second output signals, wherein the differential amplifier includes,

a first output-stage differential converter including a second grounded emitter amplifier that receives the first differential input signal and generates a first differential output signal, and a second grounded base amplifier that receives the first differential input signal and generates a second differential output signal, and

a second output-stage differential converter including a third grounded emitter amplifier that receives the second differential input signal and generates a third differential

output signal, and a third grounded base amplifier that receives the second differential input signal and generates a fourth differential output signal, wherein the first output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal; and

a pair of differential circuits connected to the differential amplifier, for receiving the first and second output signals and the first and second carrier signals to generate the first and second mixer output signals.

9. (New) A differential amplifier that receives first and second input signals and generates first and second output signals, the differential amplifier comprising:

a first single-end differential converter including a first grounded emitter amplifier that receives the first input signal and generates a first differential output signal, and a first grounded base amplifier that receives the first input signal and generates a second differential output signal, wherein the first grounded emitter amplifier includes a first transistor and a first resistor connected between an emitter of the first transistor and a ground; and

a second single-end differential converter including a second grounded emitter amplifier that receives the second input signal and generates a third differential output signal, and a second grounded base amplifier that receives the second input signal and generates a fourth differential output signal, wherein the second grounded emitter amplifier includes a second transistor and a second resistor connected between an emitter of the

second transistor and the ground, wherein the emitter of the first transistor and the emitter of the second transistor are not directly connected to each other, and wherein the first output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal.

10. (New) A differential amplifier that receives first and second input signals and generates first and second output signals, the differential amplifier comprising:

a first single-end differential converter including a first grounded emitter amplifier that receives the first input signal and generates a first differential output signal, and a first grounded base amplifier that receives the first input signal and generates a second differential output signal, wherein the first grounded emitter amplifier includes a first transistor and a first resistor connected between an emitter of the first transistor and a ground; and

a second single-end differential converter including a second grounded emitter amplifier that receives the second input signal and generates a third differential output signal, and a second grounded base amplifier that receives the second input signal and generates a fourth differential output signal, wherein the second grounded emitter amplifier includes a second transistor and a second resistor connected between an emitter of the second transistor and the ground, and wherein the first output signal is generated by cross-coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by cross-coupling the second differential output signal

and the third differential output signal so that cross-coupling improves the balance of the first and second output signals and using the first and second grounded emitter amplifiers improves linearity of the first and second outut signals.

11. (New) A differential amplifier that receives first and second input signals and generates first and second output signals, the differential amplifier comprising:

a first single-end differential converter including a first grounded emitter amplifier that has a base for receiving the first input signal and generates a first differential output signal, and a first grounded base amplifier that has a base for receiving the first input signal and generates a second differential output signal, wherein the first grounded emitter amplifier includes a first transistor and a first resistor connected between an emitter of the first transistor and a ground; and

a second single-end differential converter including a second grounded emitter amplifier that has a base for receiving the second input signal and generates a third differential output signal, and a second grounded base amplifier that has a base for receiving the second input signal and generates a third differential output signal, and a second grounded base amplifier that has a base for receiving the second input signal and generates a fourth differential output signal, wherein the second grounded emitter amplifier includes a second transistor and a second resistor connected between an emitter of the second transistor and the ground, wherein the emitter of the first transistor and the emitter of the second transistor are not directly connected to each other, and wherein the first output signal is generated by coupling the first differential output signal and the fourth

differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal.

12. (New) A mixer that mixes first and second input signals with first and second carrier signals to generate first and second mixer output signals, the mixer comprising:

a differential amplifier that receives the first and second input signals and generates first and second output signals, wherein the differential amplifier includes,

a first single-end differential converter including a fist grounded emitter amplifier that receives the first input signal and generates a first differential output signal and a first grounded base amplifier that receives the first input signal and generates a second differential output signal, wherein the first grounded emitter amplifier includes a first transistor and a first resistor connected between an emitter of the first transistor and a ground;

a second single-end differential converter including a second grounded emitter amplifier that receives the second input signal and generates a third differential output signal, and a second grounded base amplifier that receives the second input signal and generates a fourth differential output signal, wherein the second grounded emitter amplifier includes a second transistor and a second resistor connected between an emitter of the second transistor and the ground, wherein the first output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal; and

a pair of differential circuits connected to the differential amplifier, for receiving the first and second output signals and the first and second carrier signals to generate the first and second mixer output signals.

13. (New) A mixer that mixes first and second input signals with first and second carrier signals to generate first and second mixer output signals, the mixer comprising:

a differential amplifier that receives the first and second input signals and generates first and second output signals, wherein the differential amplifier includes,

a first single-end differential converter including a first grounded emitter amplifier that receives the first input signal and generates a first differential output signal and a first grounded base amplifier that receives the first input signal and generates a second differential output signal, wherein the first grounded emitter amplifier includes a first transistor and a first resistor connected between an emitter of the first transistor and a ground;

a second single-end differential converter including a second grounded emitter amplifier that receives the second input signal and generates a third differential output signal, and a second grounded base amplifier that receives the second input signal and generates a fourth differential output signal, wherein the second grounded emitter amplifier includes a second transistor and a second resistor connected between an emitter of the second transistor and the ground, wherein the first output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the

third differential output signal so that cross-coupling improves the balance of the first and second output signals and using the first and second grounded emitter amplifiers improves linearity of the first and second output signals; and

a pair of differential circuits connected to the differential amplifier, for receiving the first and second output signals and the first and second carrier signals to generate the first and second mixer output signals.

14. (New) A mixer that mixes first and second input signals with first and second carrier signals to generate first and second mixer output signals, the mixer comprising:

a differential amplifier that receives the first and second input signals and generates first and second output signals, wherein the differential amplifier includes,

a first single-end differential converter including a first grounded emitter amplifier that has a base for receiving the first input signal and generates a first differential output signal and a first grounded base amplifier that has a base for receiving the first input signal and generates a second differential output signal, wherein the first grounded emitter amplifier includes a first transistor and a first resistor connected between an emitter of the first transistor and a ground;

a second single-end differential converter including a second grounded emitter amplifier that has a base for receiving the second input signal and generates a third differential output signal, and a second grounded base amplifier that has a base for receiving the second input signal and generates a fourth differential output signal, wherein the second grounded emitter amplifier includes a second transistor and a second resistor connected between an emitter of the second transistor and the ground, wherein the first

output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal; and a pair of differential amplifier, for receiving the first and second output signals to generate the first and second mixer output signals.